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(72) Inventors:  
• **Gau, Ti-Ying Troy**  
**Taipei (TW)**  
• **Su, Yuan, Chi**  
**N. District, Hsinchu (TW)**

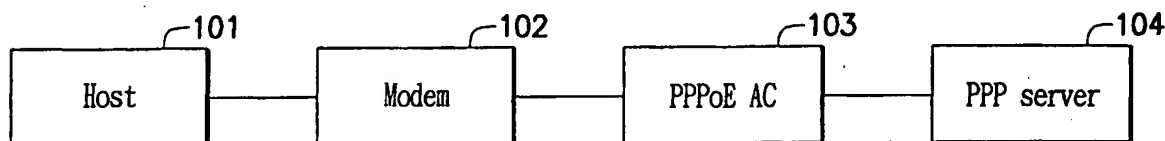
(71) Applicant: **Zyxel Communications Corporation**  
**Hsin-Chu, Taiwan (KR)**

(74) Representative: **O'Connell, David Christopher**  
**Haseltine Lake & Co., Imperial House, 15-19**  
**Kingsway**  
**London WC2B 6UD (GB)**

(54) **Modem device**

(57) A modem providing PPPoE (PPP over Ethernet) connections between the modem and a plurality of PPPoE Access Concentrators (PPPoE AC). The modem comprises a processor implementing the PPPoE

protocol, a local port coupled to a local network and a remote port coupled to an access network. The modem of this invention removes the requirement that the PPP protocol stack and the PPPoE protocol stack must reside on the same machine.



**FIG. 1 (PRIOR ART)**

## Description

### BACKGROUND OF THE INVENTION

#### Field of the Invention

[0001] The present invention generally relates to a modem device, and more particularly to a modem device that provides PPPoE(Point-to-Point Protocol over Ethernet) connections between the modem device and a plurality of PPPoE ACs(PPPoE Access Concentrator).

#### Description of the Related Art

[0002] In the OSI Reference Model, a seven-layer architecture is defined to allow equipment by different vendors to interoperate and to make applications independent of the hardware on which they run.

[0003] A modem device is a physical layer (layer 1) device that converts and relays data between two ports. A modem typically also has call control, e.g., call setup, call teardown and flow control capability. As an example, an analog modem generally has one serial port for connection to a host and one line port for interfacing to the PSTN(Public Switch Telephone Network). The analog modem handles the dialing and the hanging up of telephone calls as well as data conversion and relaying between the serial port and the line port.

[0004] The Point-to-Point Protocol (PPP) provides a standard method for transporting multi-protocol datagrams over point-to-point links. PPP is the preferred link layer (layer 2) protocol for connecting networks over WAN links. In particular, dial-up networking over PPP using serial port and modem is implemented on virtually all computing platforms.

[0005] With the advent of broadband technology, e.g., DSL and data over cable, a large number of broadband modems are equipped with an Ethernet port, as opposed to a serial port, to support the higher throughput. However, since Ethernet is not a point-to-point medium, there must be a method for transporting the PPP frames directly over Ethernet from the host running PPP to the modem. RFC 2516, "A Method for Transmitting PPP Over Ethernet (PPPoE)", provides such a method. However, it requires both the PPP protocol stack and the PPPoE protocol stack to reside on the same machine when using a conventional bridging modem.

[0006] FIG.1 is a block diagram illustrating an arrangement wherein a conventional bridging modem 102 is used in conjunction with PPPoE running on a host 101. The PPPoE connection is between host 101 and PPPoE AC 103; and the PPP connection is between host 101 and PPP server 104. Both the PPP and the PPPoE connections must terminate at host 101, since bridging modem 102 performs simple relaying of Ethernet frames only.

[0007] However, there are disadvantages when both the PPP and the PPPoE connections terminate at host

101. This is because both PPPoE AC 103 and PPP server 104 must provide host 101 with a driver for connections to be possible. If the OS (operating system) of the host 101 changes, the connections may be disabled. This requires the burdensome task of updating the driver.

### SUMMARY OF THE INVENTION

[0008] It is a general object of the present invention to provide an improved modem in which the above-mentioned disadvantages are eliminated.

[0009] A more specific object of the present invention is to provide PPPoE service in a modem. The above-mentioned objects of the present invention are achieved by a modem having a processor that implements the PPPoE protocol stack. With such a PPPoE modem, the requirement that the PPP protocol stack and the PPPoE protocol stack must reside on the same machine is removed.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The present invention is illustrated by way of example and not limited to the figures of the accompanying drawings, in which like references indicate similar elements, and in which:

FIG. 1 shows a modem that operates according to the prior art;

FIG. 2 shows the components of the present invention;

FIG. 3 shows a modem of one embodiment wherein the local connection uses PPTP; and

FIG. 4 shows the message exchange for the arrangement in FIG. 3.

### DESCRIPTION

[0011] FIG. 2 is a block diagram illustrating the major functional components of the present invention. Modem 200 includes local port 201 for interfacing to the local network, remote port 202 for interfacing to the access network and processor 205 that implements the PPPoE protocol stack for PPPoE call control and framing, and controls the operations of other components.

[0012] Before data can be relayed between local port 201 and remote port 202, a call must be set up between modem 200 and PPPoE AC 220. Processor 205 responds to a call setup message received on local port 201 from host 210 and starts the PPPoE call setup procedure on remote port 202. When the call is established, processor 205 begins relaying the PPP frames between local port 201 and remote port 202.

[0013] When a PPP frame is received on local port 201, it is decapsulated according to the encapsulation method on local port 201. After decapsulation, processor 205 encapsulates the frame in PPPoE format and

transmits it onto remote port 202. Moreover, when a frame is received on remote port 202, it is processed in a similar fashion, only in the reversed direction.

[0014] FIG. 3 shows an arrangement wherein a host on the local Ethernet network utilizes a PPPoE modem for remote access in PPPoE over an ATM network 330. More specifically, FIG. 3 shows PPPoE modem 300, host 310, PPPoE AC 340 and PPP access server 350. Local port 301 in modem 300 is coupled to the local Ethernet 320, transmitting and receiving data to and from host 310 over PPTP (Point-to-Point Tunneling Protocol). Remote port 302 is coupled to ATM network 330 and carries the traffic in PPPoE over AAL5 (ATM Adaptation Layer 5). Processor 305 implements the PPPoE protocol stack for PPPoE call control and framing, and controls the operations of Local port 301, Remote port 302, and other components.

[0015] Note that even though FIG. 3 shows only one host, one PPPoE AC and one PPP access server, it is possible to have a plurality of hosts on the local Ethernet, each instantiating a separate PPTP control connection to the PPPoE modem. It is also possible for a single host to request multiple calls within the PPTP control connection to create PPP sessions to different PPP access servers.

[0016] FIG. 4 illustrates the message exchange between modem 400 and host 410 over PPTP and between modem 400 and PPPoE AC 420 over PPPoE. After a TCP connection between modem 400 and host 410 is first instantiated, PPTP message exchange starts. Host 410 first sends a PPTP Start-Control-Connection-Request S31 to modem 400 to initiate a PPTP control connection. Modem 400 responds by sending a PPTP Start-Control-Connection-Reply S32 to host 410, at which point in time a PPTP control connection is established. Host 410 then sends a PPTP Outcall-Request S33 to request modem 400 to place an outgoing call. Modem 400 initiates an outgoing call by sending a PPPoE Active Discovery Initiation S41 in Ethernet broadcast address on the ATM network to which modem 400 is coupled. PPPoE AC 420 sends a PPPoE Active Discovery Offer S42 to modem 400 to indicate the availability of the service, at which time modem 400 learns the Ethernet address of PPPoE AC 420 that offers the service. Modem 400 then sends a PPPoE Active Discovery Request S43 to PPPoE AC 420. PPPoE AC 420 then sends a PPPoE Active Discovery Session S44 to modem 400 to complete the PPPoE call setup procedure. Upon receiving PPPoE Active Discovery Session S44, Modem 400 sends a PPTP Outcall Reply S34 to host 410 to indicate that the call is successful. At this point modem 400 is in data state. After receiving a successful PPTP Outcall Reply S34 from modem 400, host 410 starts transmitting and receiving PPP frames in GRE (General Routing Encapsulation) S35 according to PPTP specification. Modem 400 receives PPP frames in GRE S35 from host 410 and relays them to PPPoE AC 420 in PPPoE encapsulation S45. Similarly, Modem 400

receives PPP frames from PPPoE AC 420 in PPPoE encapsulation S45 and relays them to host 410 in GRE S35.

When host 410 wishes to terminate the call, it sends a PPTP Call Clear Request S36 to modem 400. Modem 400 first sends a PPPoE Active Discovery Terminate S46 to PPPoE AC 420 to tear down the PPPoE call and then sends a PPTP Call Disconnect Notify S37 to notify host 410 of the call disconnection.

[0017] After the session is over, the PPTP control connection can be kept alive or stopped at the discretion of either host 410 or modem 400. If host 410 wishes to stop the PPTP control connection, it sends a PPTP Stop Control Connection Request S38 to modem 400. Modem 400 responds by sending a PPTP Stop Control Connection Reply S39 to host 410, at which time the PPTP control connection is terminated.

[0018] By providing a modem having a processor that implements the PPPoE protocol stack, the present invention eliminates the requirement that PPPoE protocol stack and the PPP protocol stack reside on the same machine.

[0019] While the invention has been described by way of example and in terms of the preferred embodiment, it is to be understood that the invention is not limited to the disclosed embodiments. On the contrary, it is intended to cover various modifications and similar arrangements as would be apparent to those skilled in the art. Therefore, the scope of the appended claims should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements, which is defined by the following claims and their equivalents.

## Claims

1. A modem device located between at least a host and at least a PPPoE access concentrator, comprising:  
a processor coupled to said host and said PPPoE access concentrator to implement at least the PPPoE protocol that provide PPPoE control and encapsulation functions, and transport a signals to said host and said PPPoE respectively.
2. The modem device as claimed in claim 1, further comprising a locate port coupled to said host.
3. The modem device as claimed in claim 2, further comprising a remote port coupled to said PPPoE access concentrator.
4. The modem device as claimed in claim 3, wherein said processor controls said locate port to make the communication between said host and said modem

device.

5. The modem device as claimed in claim 4, wherein said processor controls said remote port to make the communication between said PPPoE access concentrator and said modem device. 5
6. The modem device as claimed in claim 4, wherein said processor controls the relaying of PPP frames between said local port and said remote port. 10
7. A modem device located between at least a host and at least a PPPoE access concentrator, comprising: 15
  - a remote port coupled to said PPPoE access concentrator;
  - a locate port coupled to said host; and 20
  - a processor coupled to said remote and said locate port to implement at least the PPPoE protocol that provide PPPoE control and encapsulation functions, and transport a signals to said host and said PPPoE access concentrator with said locate port and said remote port respectively. 25
8. The modem device as claimed in claim 7, wherein said processor controls said locate port to make the communication between said host and said modem device. 30
9. The modem device as claimed in claim 8, wherein said processor controls said remote port to make the communication between said PPPoE access concentrator and said modem device. 35
10. The modem device as claimed in claim 9, wherein said processor controls the relaying of PPP frames between said local port and said remote port. 40

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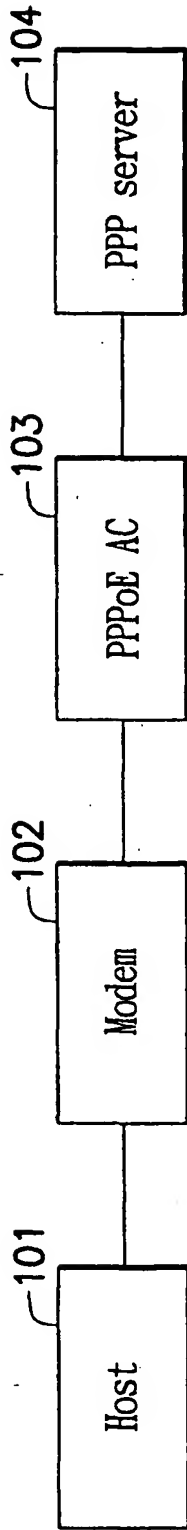


FIG. 1 (PRIOR ART)

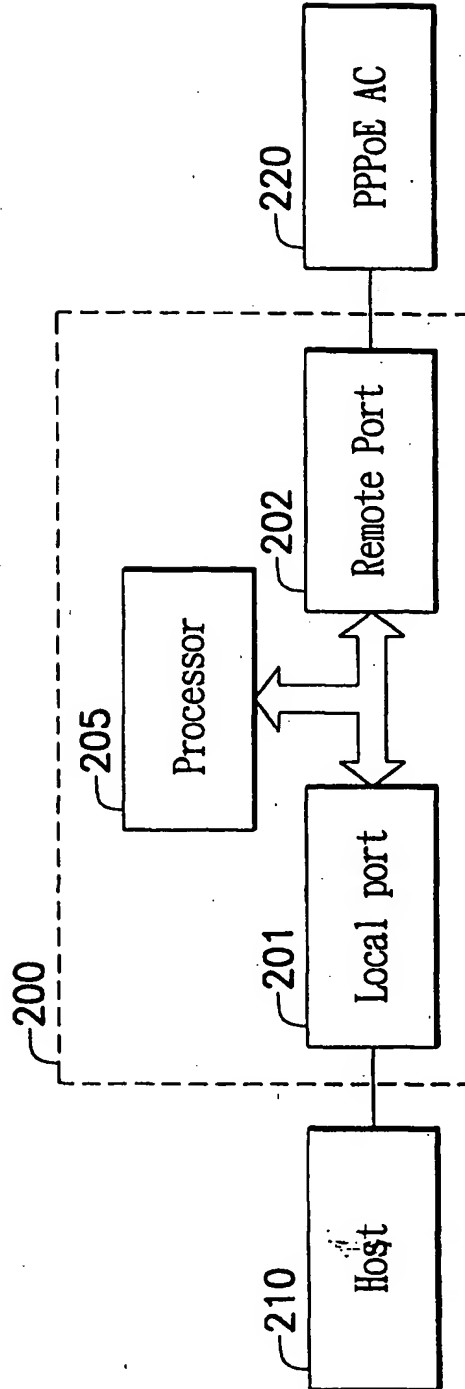


FIG. 2

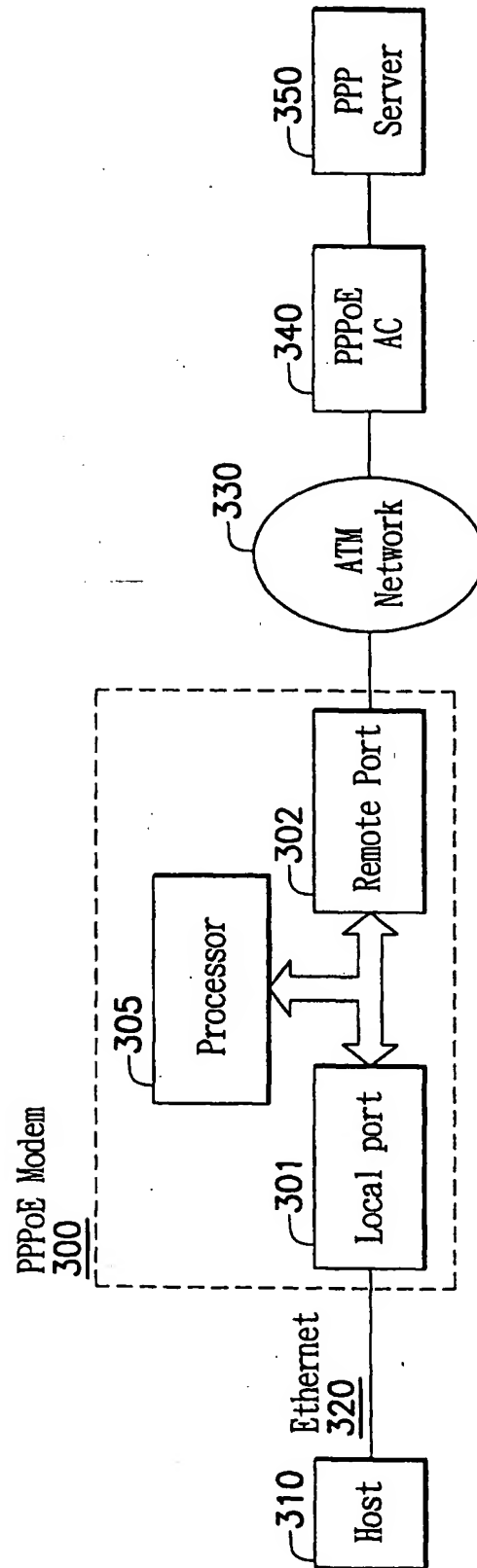


FIG. 3

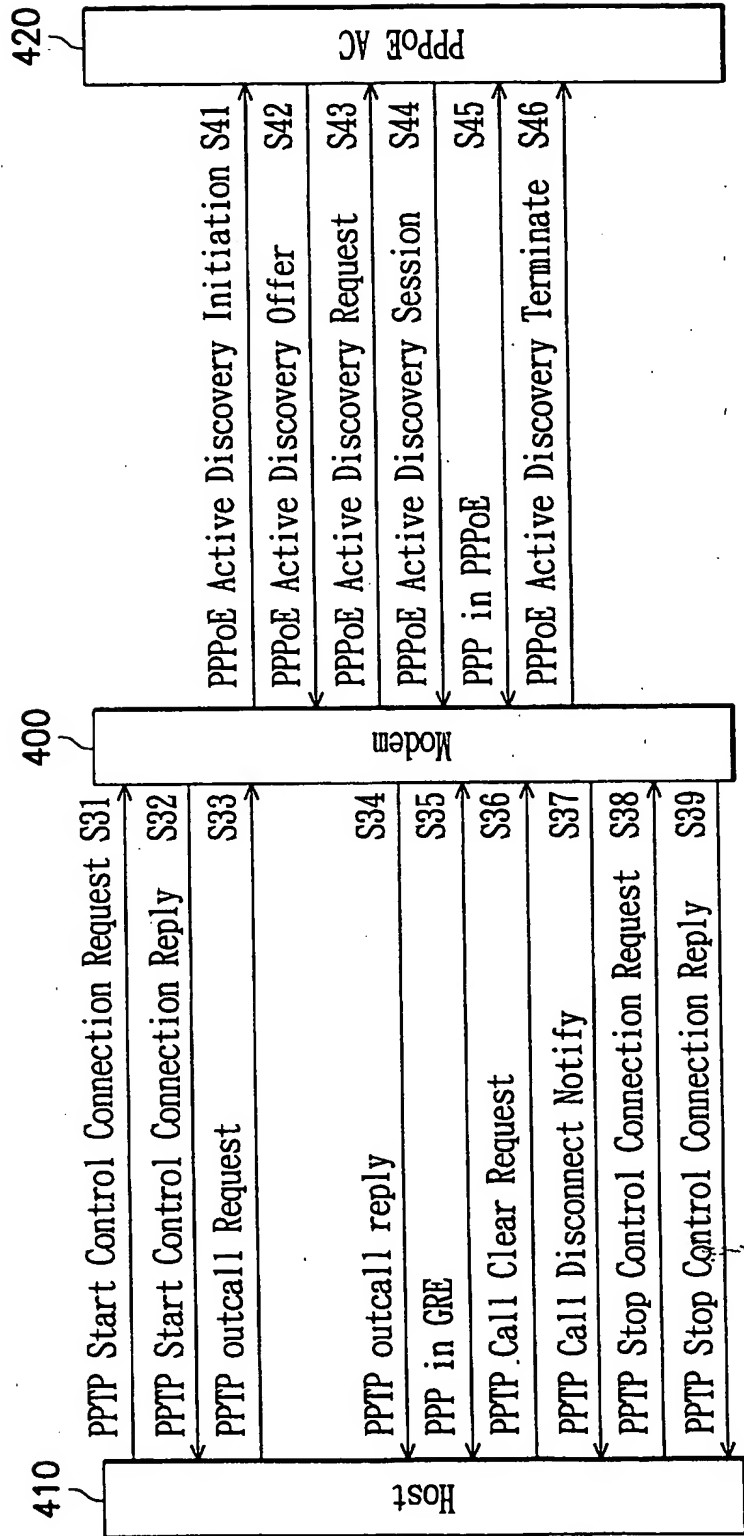


FIG. 4



European Patent  
Office

# EUROPEAN SEARCH REPORT

Application Number  
EP 00 30 7020

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	WO 99 65219 A (IREADY CORP) 16 December 1999 (1999-12-16) * abstract; figure 3 * * page 7 - page 8 * * page 25 *	1-10	H04M11/06
A	US 5 867 660 A (BARON PETER ET AL) 2 February 1999 (1999-02-02) * abstract * * page 2 - page 5 * * page 8; claim 1 *	1-10	
D,A	L. MAMAKOS, K. LIDL, J. EVARTS, D. CARREL, D. SIMONE, R. WHEELER: "A Method for Transmitting PPP over Ethernet (PPPoE)" IETF RFC 2516, 1 February 1999 (1999-02-01), XP002159712 * the whole document *	1-10	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			H04M H04L
The present search report has been drawn up for all claims			
Place of search <b>THE HAGUE</b>		Date of completion of the search <b>12 February 2001</b>	Examiner <b>Stergiou, C</b>
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons &amp; : member of the same patent family, corresponding document</p>			

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**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 00 30 7020

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on  
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12-02-2001

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9965219 A	16-12-1999	AU 4435999 A	30-12-1999
US 5867660 A	02-02-1999	NONE	

EPO FORM P0469

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82